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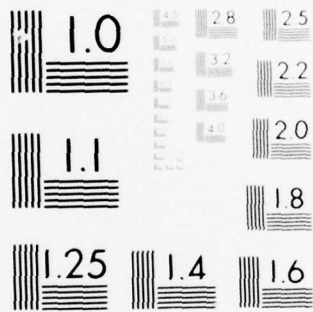
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Upper Atmosphere Chemical Release and Smoke Trail Triangulation,
1974 - 1977

Robert G. Roper
Howard D. Edwards

Georgia Institute of Technology
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August 1977

Final Report, Contract F-19628-74-C-0085

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Introduction

For many years the School of Aerospace Engineering at Georgia Tech has provided field support to the Aeronomy division of the Air Force Geophysics Laboratory. In the early 1960's camera and timing equipment was developed specifically for high resolution photography from three sites of upper atmosphere chemical releases in the lower thermosphere to enable triangulation of the chemical release position with time, and the calculation of the winds responsible for the observed dispersion. More recently, this equipment has been used to photograph smoke trails released in the stratosphere.

During this final grant period (1974 - 1977), four field trips were undertaken - one to Fort Churchill, Canada, in March/April of 1975, for the purpose of photographing lower thermospheric releases in an investigation of atmospheric waves generated by aurorae and the auroral electrojet, and three to White Sands, New Mexico, (June 1975, July 1976, and April 1977), where smoke trails were photographed in an investigation of stratospheric dynamics.

Three scientific reports have been published.

1. "Chemical Release Triangulation and Winds in the Altitude Range 53 to 160 KM, October, 1973", by Robert G. Roper and H. D. Edwards, AFGL-TR-75-0095, March 1975.
2. "Chemical Release Triangulation and Winds in the Altitude Range 93 km to 1976 km, October 1973 and June 1974", by Robert G. Roper and H. D. Edwards, AFGL-TR-76-0063, March 1976.
3. "A Comparison Between Ground Based and Aircraft Triangulation of Chemical Releases in the Lower Thermosphere",

Robert G. Roper and Howard D. Edwards, AFGL-TR-77-0089, April 1977.

Field Trips

Photographs were taken of nine rockets launched during April 1975 from the Churchill Research Range, Manitoba, Canada in a program to investigate atmospheric waves generated by the auroral electrojet and the aurora. The program was designed to measure auroral perturbations of ionospheric parameters, such as winds, temperature, densities, electric fields and mass spectra.

In June of 1975, smoke trails from three rockets launched at White Sands Missile Range (WSMR) were photographed. In this, as in the subsequent 1976 and 1977 programs, the objective was the investigation of stratospheric dynamics at relatively small scales of motion.

In July of 1976, one smoke trail was photographed, again at WSMR.

Similarly in April 1977, three smoke trail releases were photographed at WSMR.

As part of this service contract, the films from the cameras at each site were processed by the Photo Lab at Georgia Tech to the desired characteristics requested by the sponsor, and forwarded to AFGL for subsequent analysis.

Scientific Reports

In "Chemical Release Triangulation and Winds in the Altitude Range 53 to 160 km, October 1973" by Roper and Edwards (AFGL-TR-75-0095, March 1975), chemical release position data from three rockets, and horizontal and vertical wind variation for one of these, were computed and tabulated. The position data was used subsequently by AFGL personnel for the analysis of spectral records of chemical reaction radiance intensities. The wind variations tabulated and graphed for rocket WYNEE (10/19/73), 0615 CDT) are of particular interest in that the released material was titanium tetrachloride, which produced a trail

visible over the height range 53 to 82 KM, much lower than usual for the chemical release technique.

"Chemical Release Triangulation and Winds in the Altitude Range 93 km to 176 km, October 1973 and June 1975" by Roper and Edwards (AFGL-TR-76-0063, March 1976) presented detailed tabulations and graphs of chemical release position data and winds from one rocket (ULYSSA) launched in October 1973, and three rockets (PRE-ALLADIN, ETTY and JOAN) which were part of the international ALLADIN program.

In "A Comparison Between Ground Based and Aircraft Triangulation of Chemical Releases in the Lower Thermosphere" by Roper and Edwards (AFGL-TR-77-0089, April 1977) wind profiles as determined from the ground based triangulation of three ALLADIN rockets are compared with the profiles determined by triangulation from a high flying aircraft. In the light of the improvement in observational and analysis techniques which have been made since 1974, it was concluded that the airborne measurements, although costly, could provide similar accuracy to the groundbased measurements, with the added advantages of not being hampered by surface weather, and cloud cover in particular, accompanied by a reduction in foreground atmospheric scattering which enables photographs of daylight releases to be obtained with a standard camera and relatively simple filter system.

Recommendations

Although the chemical release and smoketrail methods of determination of atmospheric dynamics have been in use for some time, it is only in recent years that the full potential of these techniques has been realized. The need for "ground truth" calibration of proposed satellite lower thermospheric dynamics remote sensing instruments, for example, will make further programs such as

ALLADIN, a necessity.

Over the period of this contract, some problems were encountered with the cameras and timing instrumentation. This is not really surprising, in that the equipment has been in use for over fifteen years, in environments ranging from the severe cold of midwinter in the Arctic, to the heat and sand of the midsummer desert, with high humidity and sea coast environments also encountered. These problems should not arise in the future, with the use of alternate, more modern equipment.